An inside-out look at NEON:

Where are we and what challenges and opportunities lie ahead?

Scott Ollinger, Observatory Director,
and the National Ecological
Observatory Network Science team

AmeriFlux meeting, May 5, 2014

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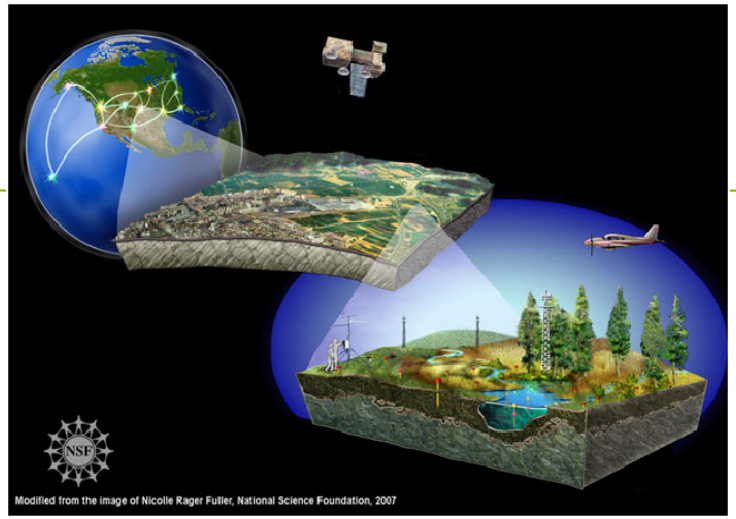
What is NEON?



- **Large science *facility* funded by the National Science Foundation**
- **A distributed, continental observatory designed to:**
  - Collect and openly distribute data on the drivers of, and responses to, ecological change
  - Provide a standardized framework for additional research and experiments
  - Develop educational resources to engage universities and communities in working with ecological data
- **First MREFC (Major Research Equipment and Facilities Construction) investment in biology.**

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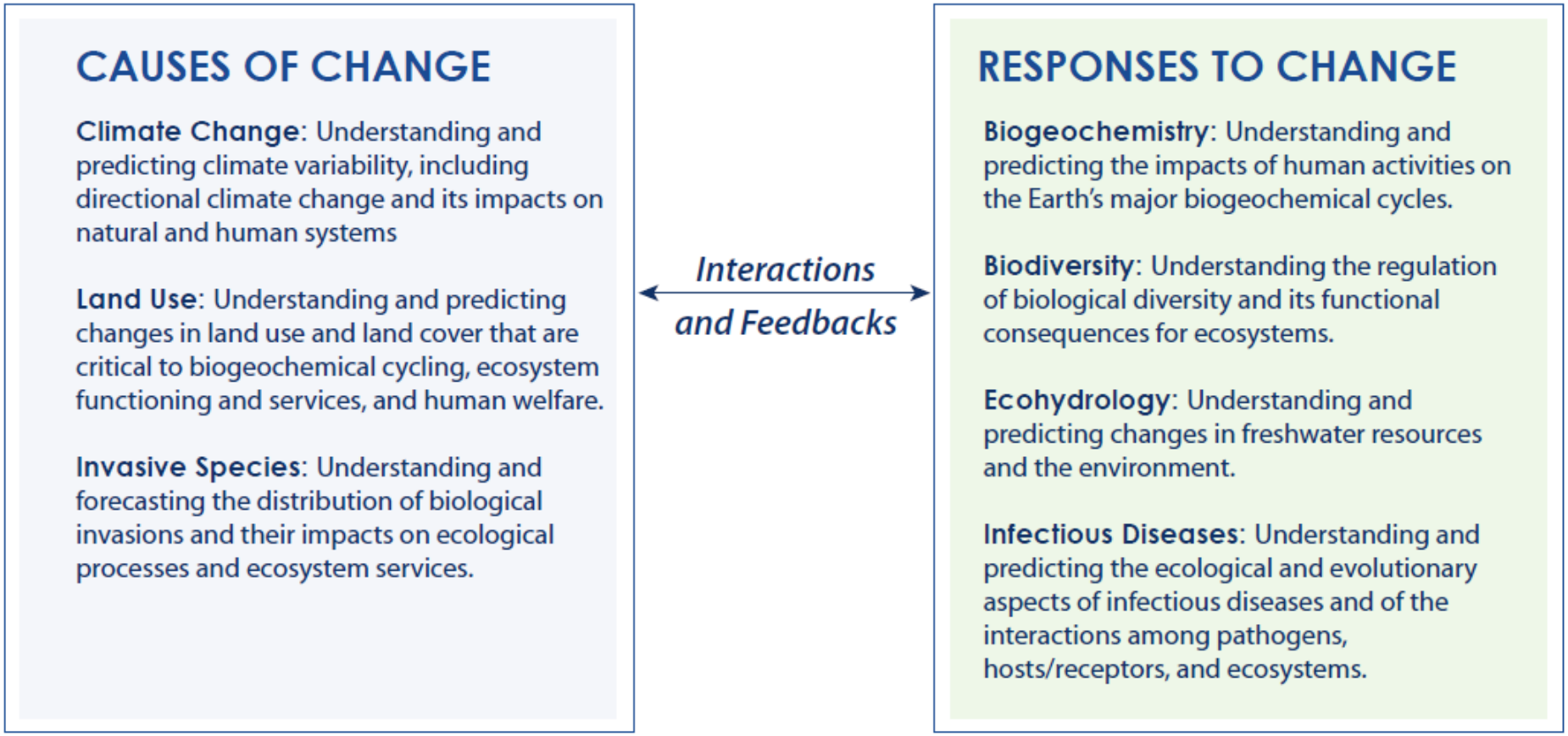
Grand Challenge areas NEON is designed to address



NRC (National Research Council). 2001. Grand Challenges in Environmental Sciences. Washington DC: National Academies Press.

NRC (National Research Council). 2003. NEON: Addressing the Nation's Environmental Challenges. Washington DC: National Academies Press.

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A few defining features

- Coordinated measurements of multiple ecological processes across a variety of scales.
- Continental scope and 30-year time horizon.
- 1st ecological observation system to employ a systems engineering approach.
- Standardized data collection, high investment in CAL/VAL & QA/QC.
- >11,000 sensors + human biological observations at full operation.
- Open data policy: Every student, post doc, and career scientist will have their own $400M science facility.
- Really dedicated team.

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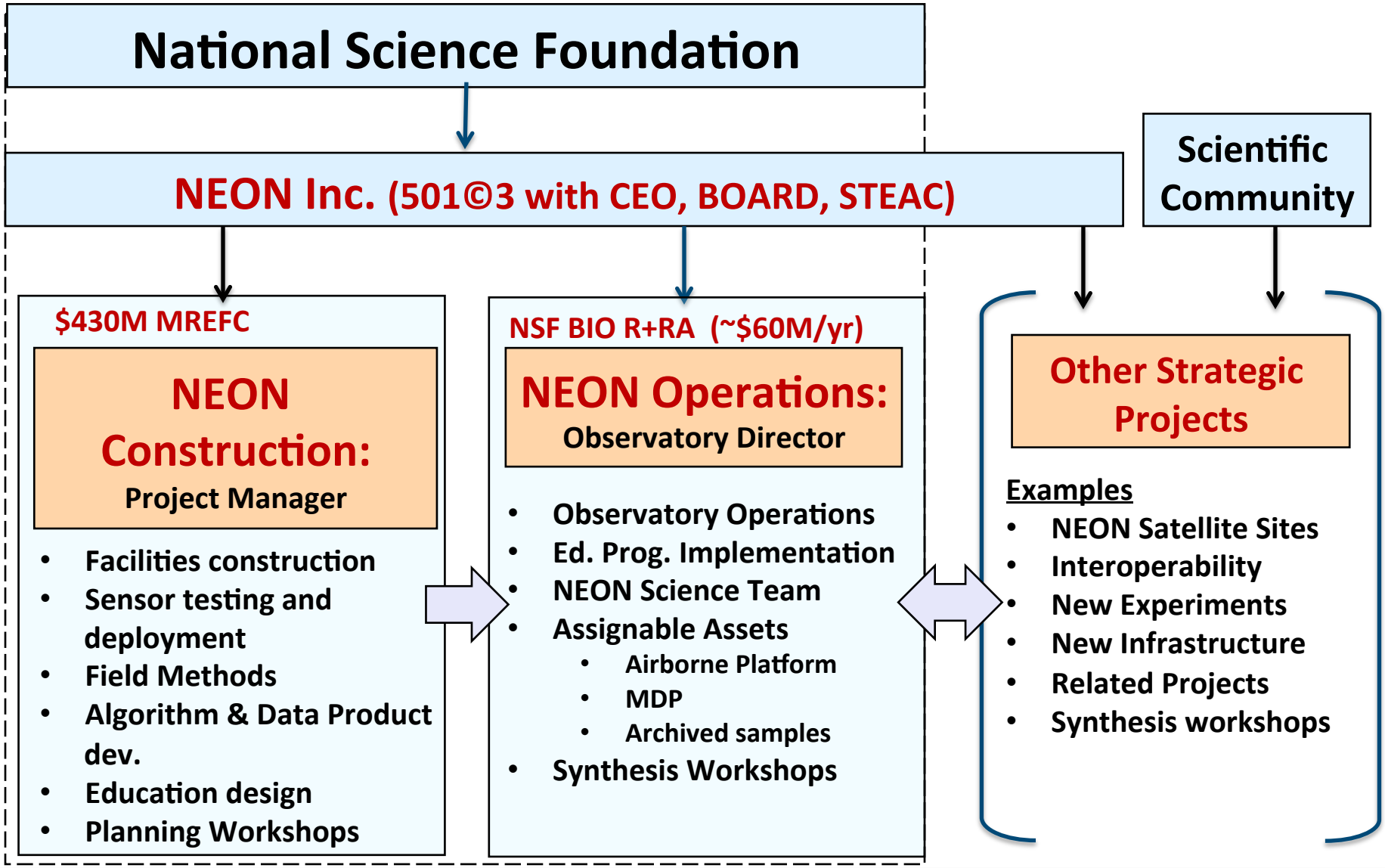
Institutional Structure



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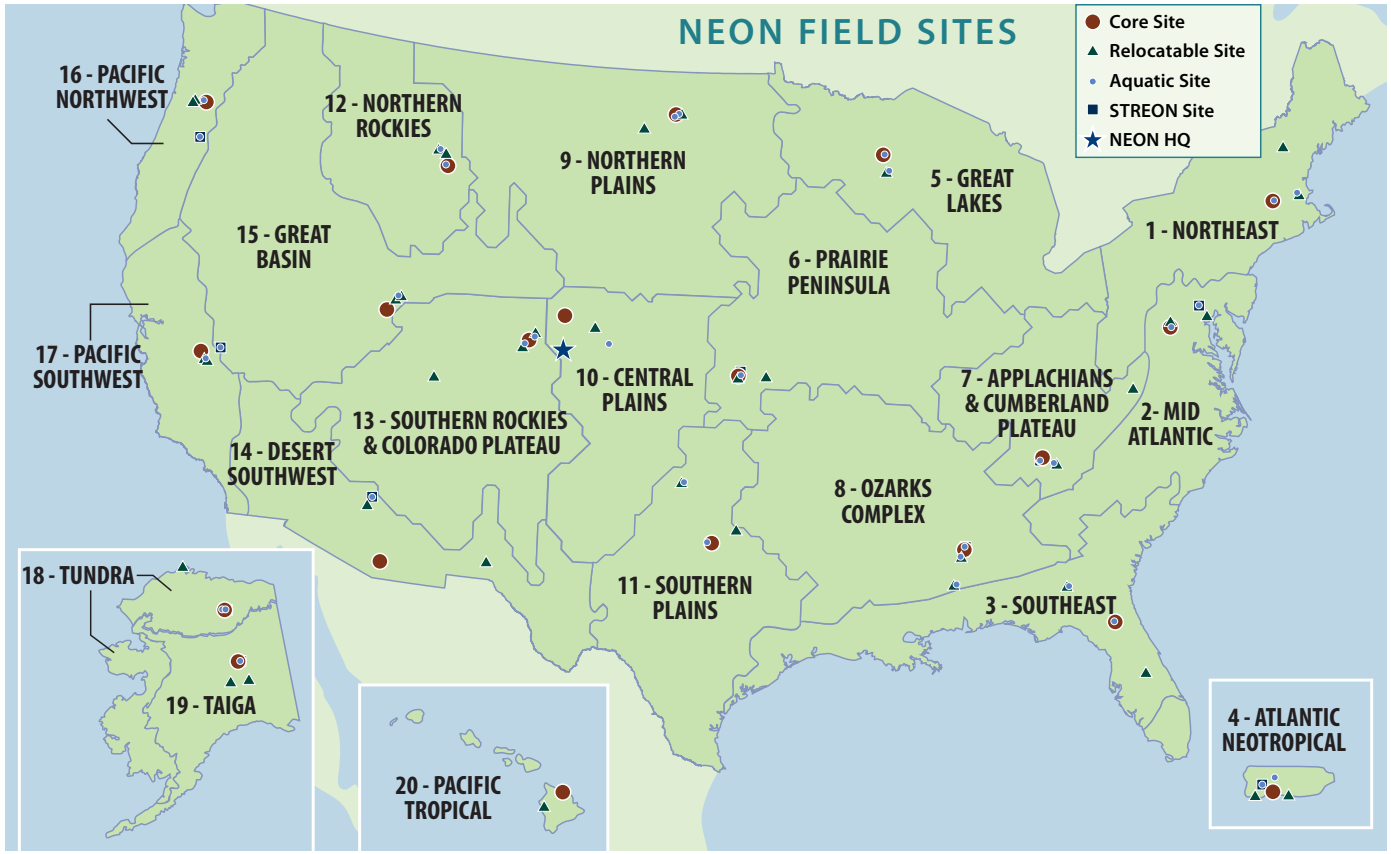
NEON's Continental-Scale Design

U.S. Divided into 20 eco-climatological domains



1. **Core sites (20):** Unmanaged native ecosystems
2. **Relocatable sites (40):** Ecosystems under human management.
3. **Aquatic sites (36):** 25 wadeable streams, 3 large rivers, 8 lakes
4. **STREON sites (10):** Experiments in nutrient addition and predator removal
5. **AOP:** Aircraft Observation Platform
6. **LUAP:** Land use analysis package
7. **MDP:** Mobile deployment units
8. **Scaling** with HyspIRI and other NASA sensors

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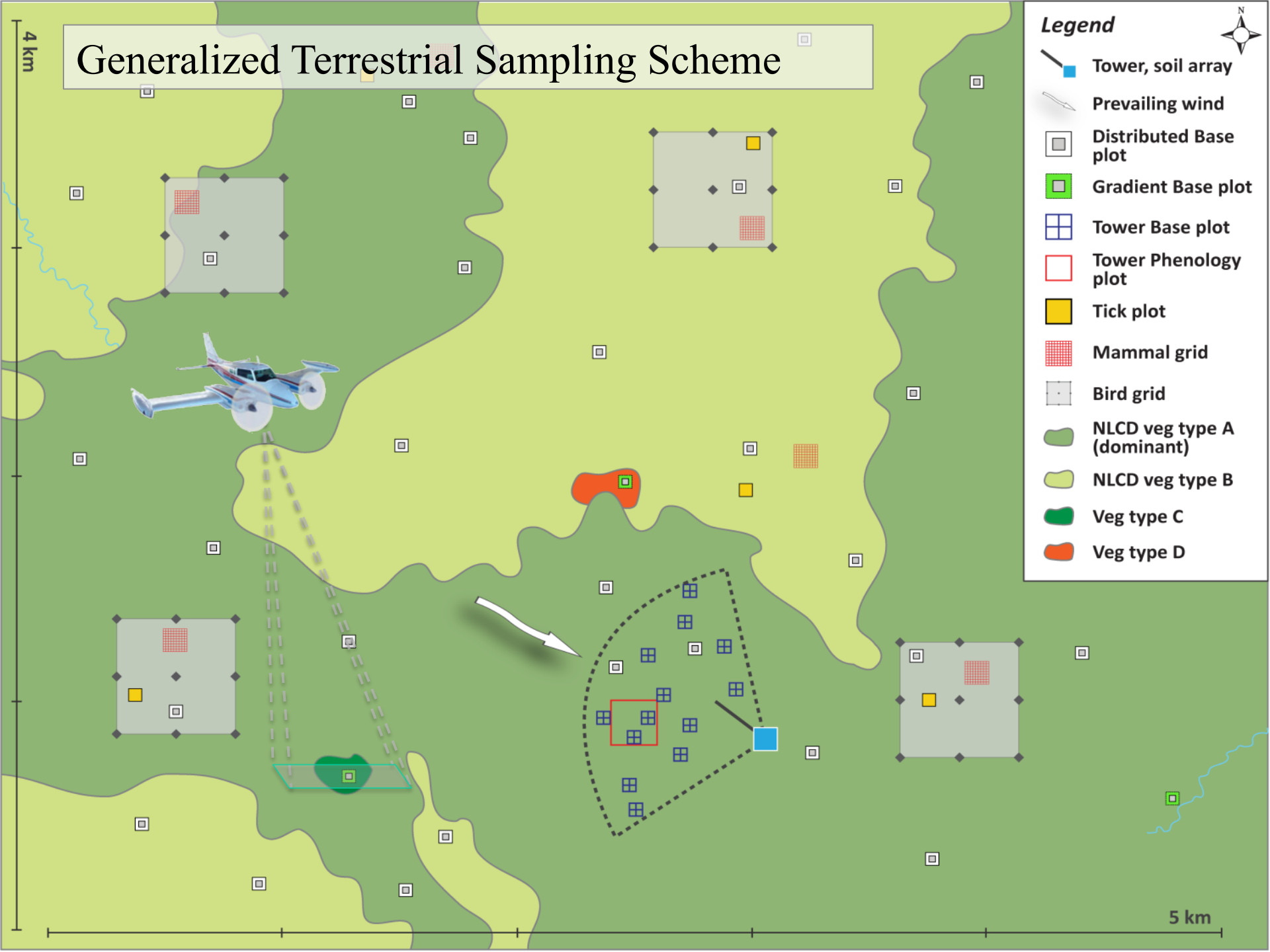
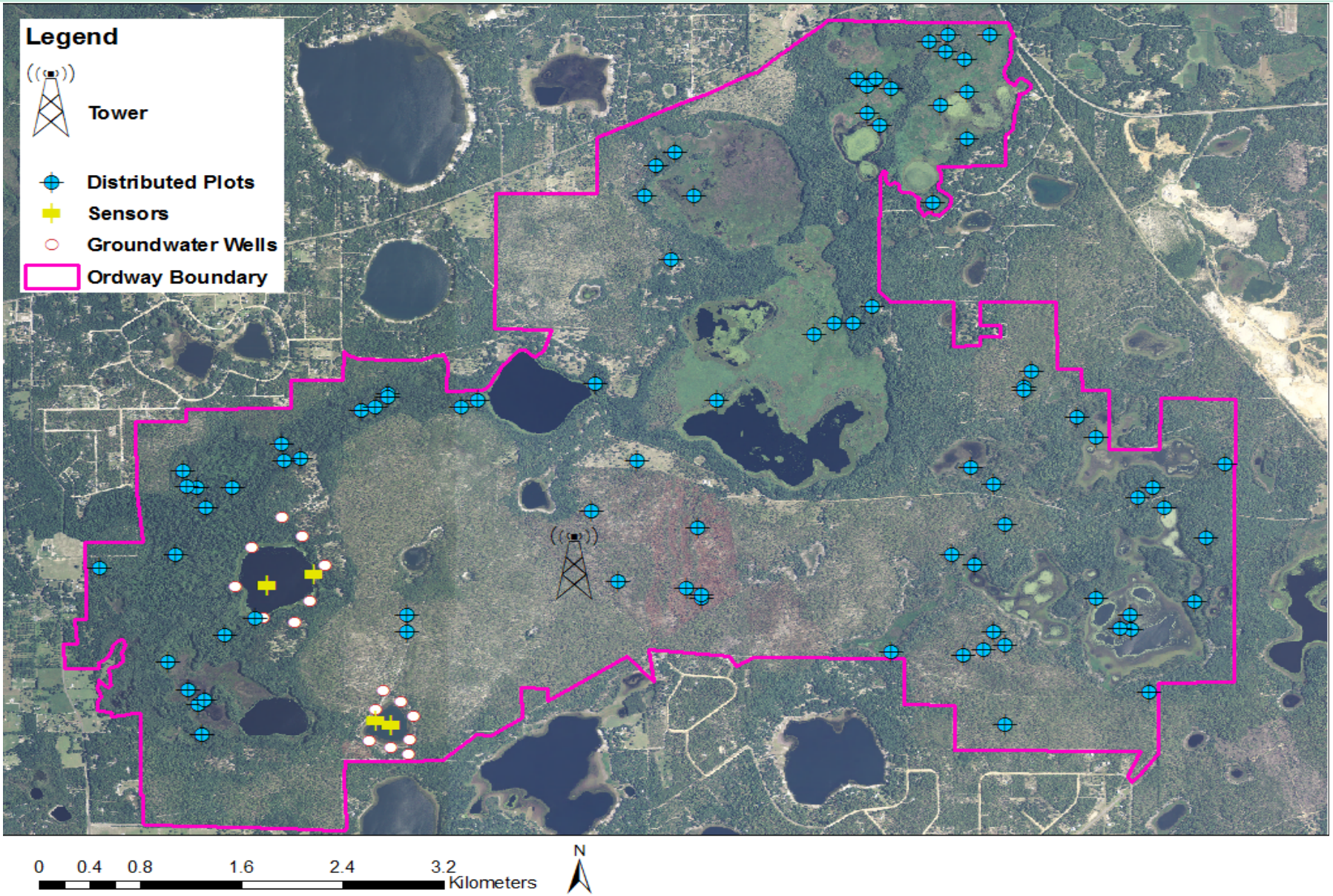

Generalized Terrestrial Sampling Scheme
4 km
5 km
Legend
Tower, soil array
Prevailing wind
Distributed Base plot
Gradient Base plot
Tower Base plot
Tower Phenology plot
Tick plot
Mammal grid
Bird grid
NLCD veg type A (dominant)
NLCD veg type B
Veg type C
Veg type D

Example of instrumented site: Ordway-Swisher, FLA

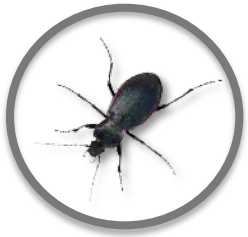


Organismal & Biogeochemical Observations

Ticks
Pathogens

Mosquitoes
Phenology
Diversity
Abundance
Pathogens

Small mammals
Diversity
Abundance
Pathogens

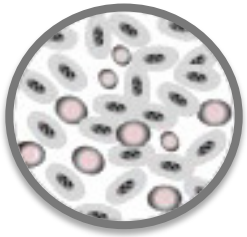


Ground beetles
Diversity
Abundance

Birds
Diversity
Abundance

Plants
Phenology
Diversity
Abundance
Productivity & Biomass

Biogeochemistry
Pools/fluxes:
Soils, plants, ground water



Soil microbes
Phenology
Diversity
Abundance
Function

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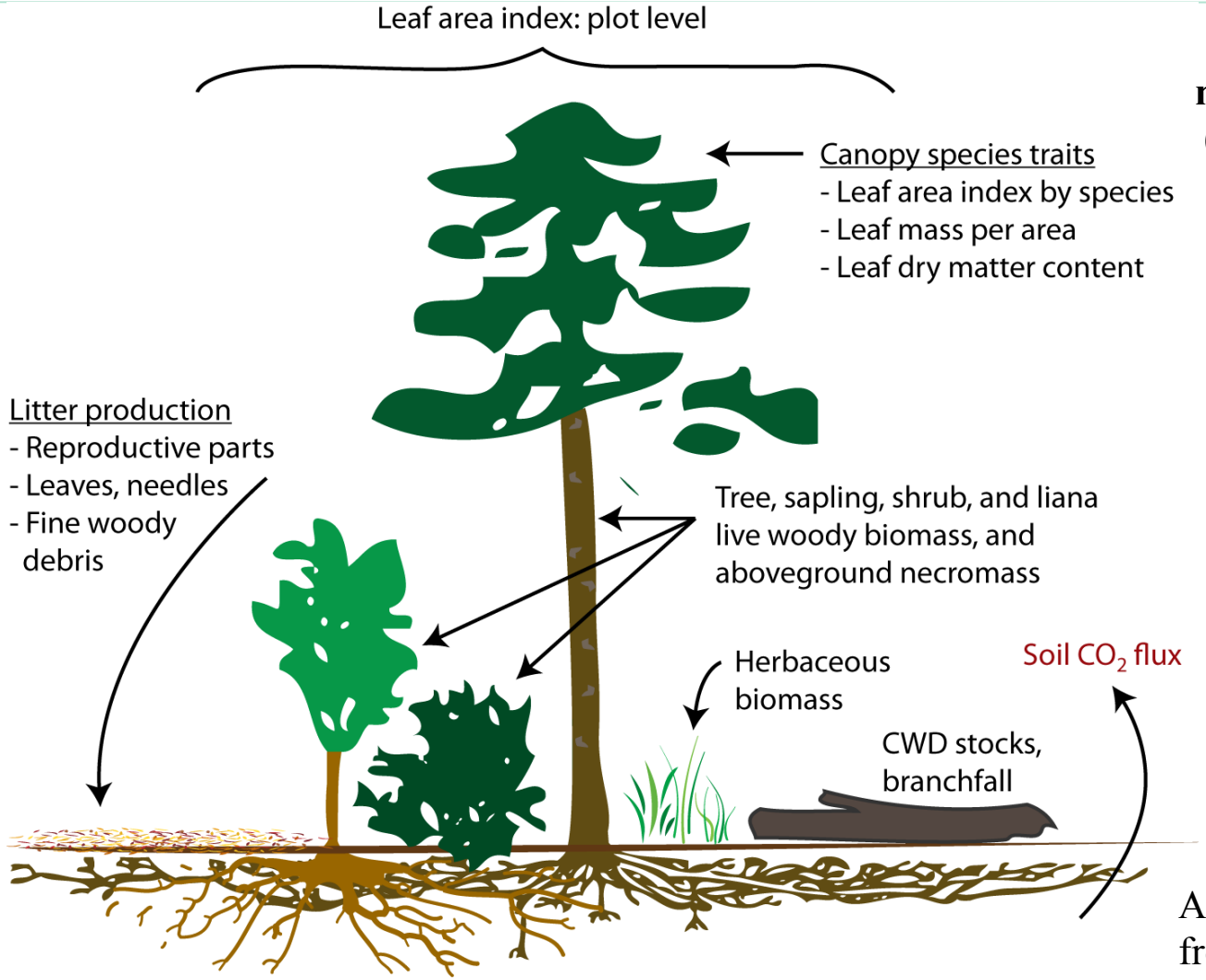
Terrestrial Instrument Measurements: Tower and tower footprint

	Measurement	Sens
SOIL	Soil CO_2 profile & flux	1Hz, Vaisala GMP343
	Soil Total C and Nutrients	Collaboration with NRCS
	Root: turnover, biomass, depth	Minirhizotron; 26 times/year, sensor TBD
DEPOSITION	Precipitation (NADP suite; δ^2H, $\delta^{18}O$)	1Hz, Belfort AEPG600M (core); 2Hz, Met One 372 (relocatable)
	Throughfall H2O	2Hz, Met One 372
MET & FLUX	CO_2 profile; $\delta^{13}C$	0.5Hz, Picarro G2101-I gas analyzer
	PAR input to ground	1Hz, Li-Cor 191
	Water vapor (δ^2H, $\delta^{18}O$)	0.5Hz, Picarro G2101-I and L2120-I
	CO_2 Conc.. and flux	20Hz, LI7200
	3D wind speed and direction	20Hz, CSAT3 sonic anemometer

Plant Biomass and Chemistry

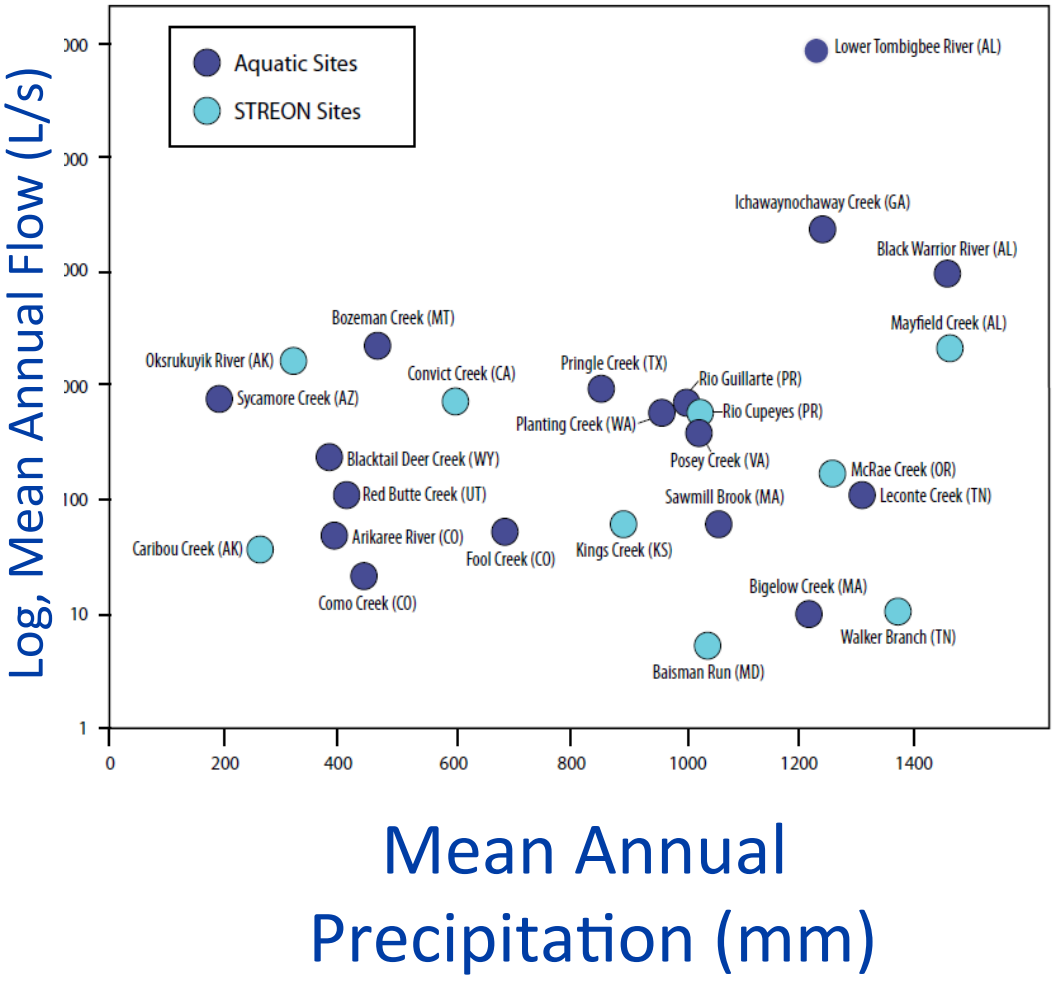


Chemical and isotopic measurements of sun-lit foliage (dominants and co-dominants)

Analyte	Frequency
Total C	every 5y
Total N	
Total S	
Total P	
$\delta^{13}C$	
$\delta^{15}N$	
Chlorophyll	
Lignin	
Cations	

Additional isotope data possible from litter, fine roots, herbaceous biomass (archive)

NEON Aquatic Sampling



Algae: composition, biomass, chlorophyll, chemistry.

Macrophytes, bryophytes, lichens

Microbes: biomass, diversity and functioning

Invertebrates, zooplankton: composition and diversity.

Fish: population, diversity, and mass.

Select Isotopes: related to food web characteristics

Surface water: physical properties, dissolved nutrients, isotopes.

Groundwater: physical properties, dissolved nutrients, isotopes.

Sediments: physical and chemical properties.

STREON: Experiments in **(1)** nutrient addition and **(2)** predator removal.

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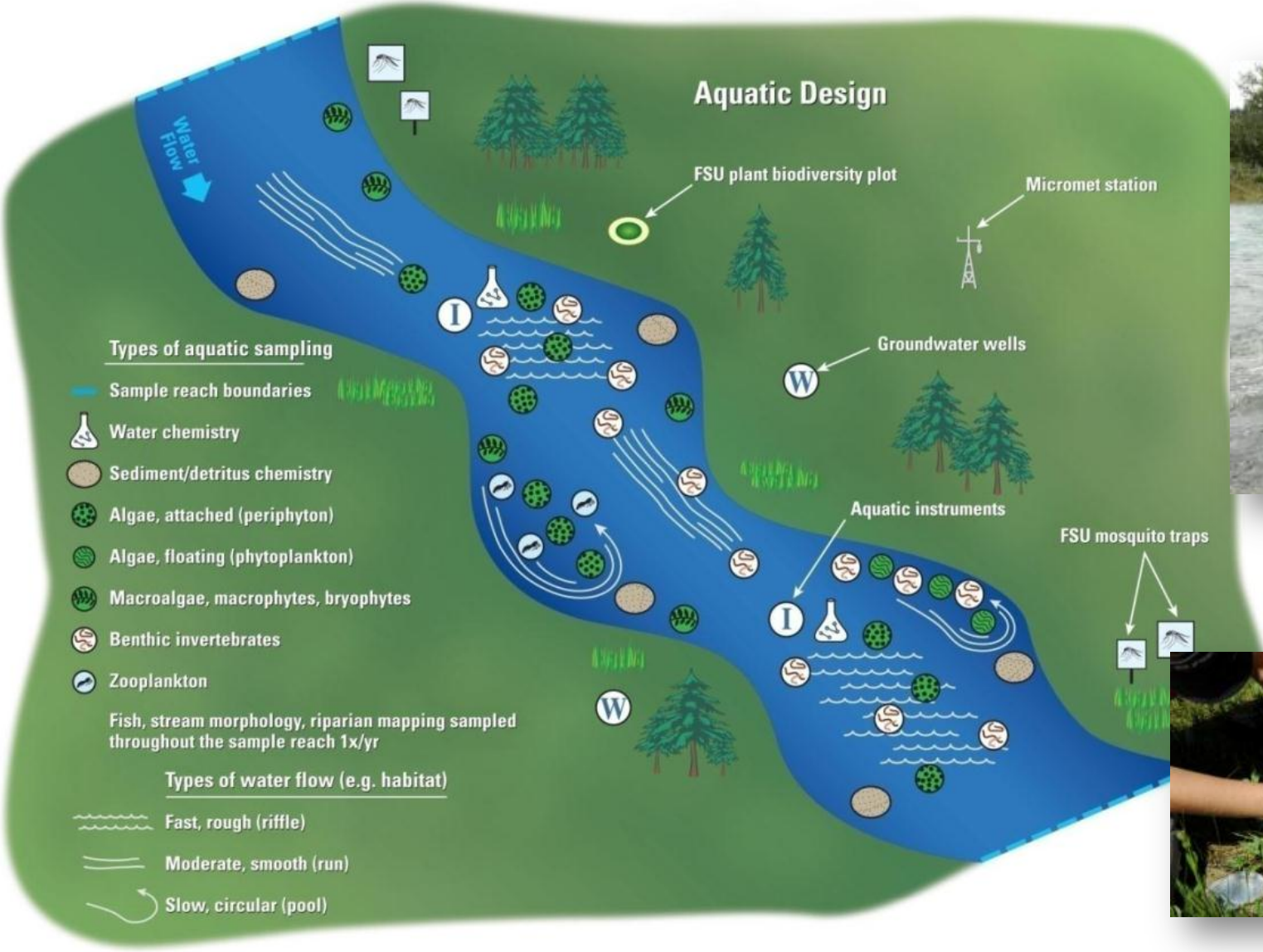
Generalized Aquatic Sampling Scheme



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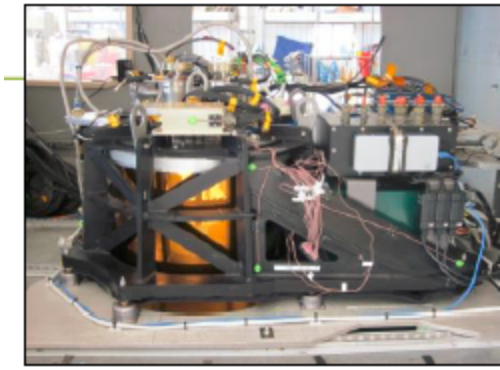
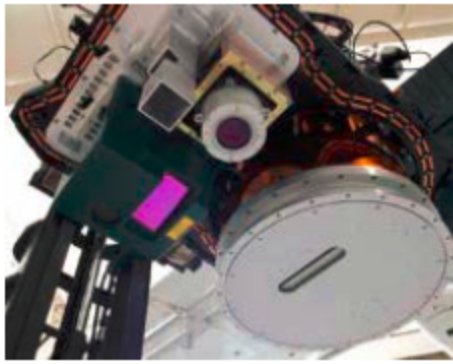
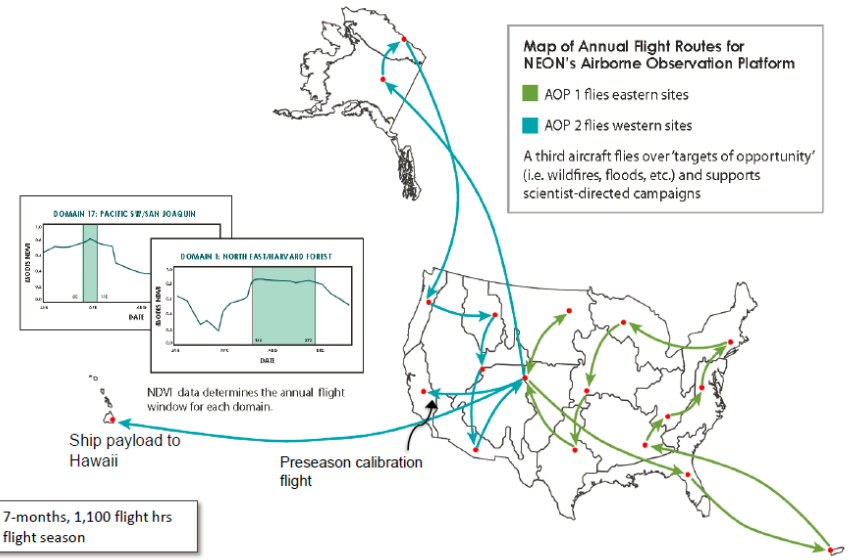
NEON Airborne Observation Platform Payload

- **Remote Sensing Payload**
  - Waveform-LiDAR
  - NEON VSWIR Imaging Spectrometer
    - 34 deg x-track FOV
    - 380-2510 nm
    - 6 nm FWHM
  - Airborne digital camera
- Flown on De Havilland DHC-6-300 twin turbo prop Twin Otter aircraft







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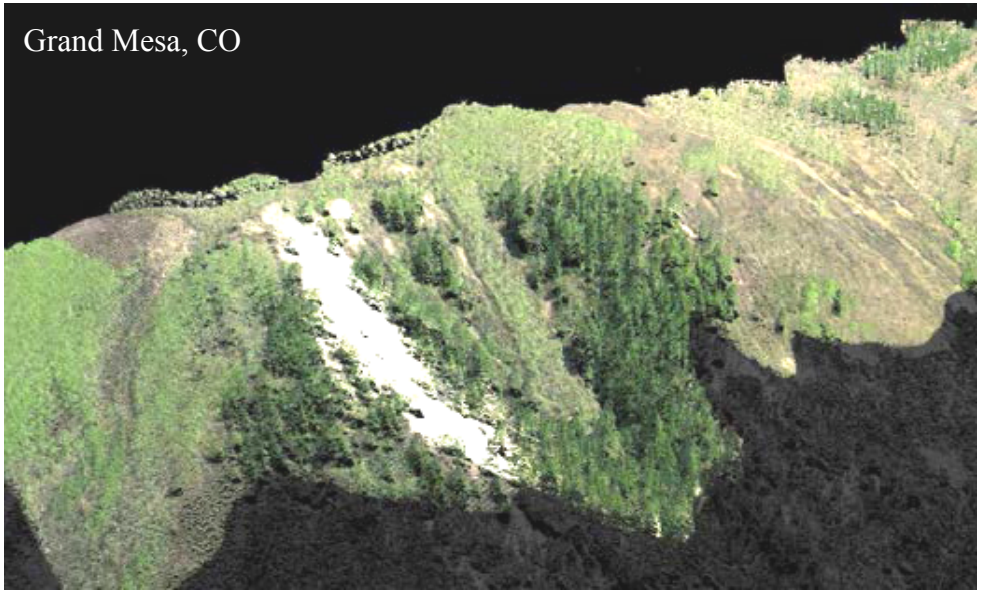
AOP Data Products



Canopy chemistry: Nitrogen, chlorophyll and other correlates of photosynthesis.

Canopy moisture (hyperspectral)

Leaf area (LiDAR)

Canopy and landscape structure: 3-D foliage distribution and ground returns.

Canopy height and tree height (LiDAR)

Land cover and aspects of land use: from interpretation of photogrammetric images and spectral/LiDAR imagery.

Spectral and structural diversity: (from hyperspectral and LiDAR).

Disturbance: from spatial patterns and their change over time

HyspIRI Preparatory Project

Goal:

Obtain low-altitude airborne and ground measurements at the NEON sites in California coincident with the “HyspIRI-like” flights

NASA

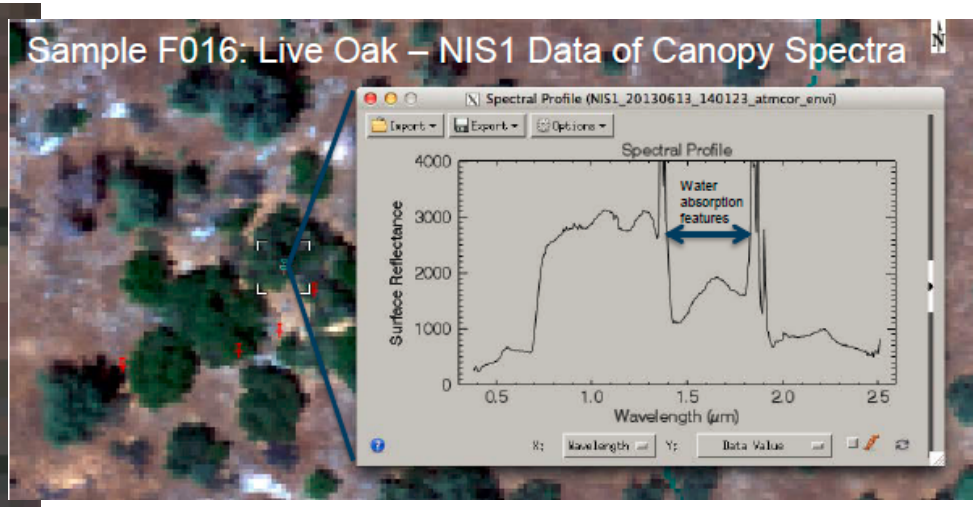
- Flew AVIRIS-classic on ER-2
  - 18-m spatial resolution
  - 20 km altitude
  - Airspeed: 730 km/hr

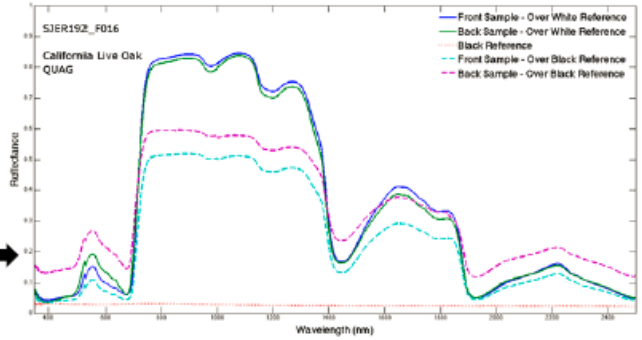
NEON

- Flew the AOP NIS1 onboard Twin Otter over NEON Domain 17 sites
  - 1-m spatial resolution
  - Altitude:1000 m AGL
  - Airspeed: 90 to 100 knots

- Collected field hyperspectral data and foliar samples for subsequent chemistry measurements

NEON AOP and the NASA HyspIRI Preparatory Project





NIS1 Surface Reflectance – 1m spatial resolution

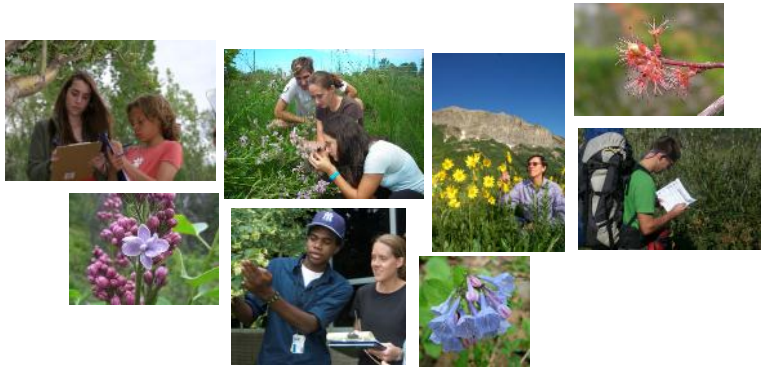
Red push pins mark field sampling sites

NEON education and public engagement:

Project Budburst

A **network** of people across the United State monitoring plants as the seasons change to better understand changing climates.

www. BudBurst.org



Mobile Access

Online Access

2013 NEON Undergraduate Internships

Ecology - Nicole Dear, UMI

"Successional Changes in Soil Microbial Communities in a Northeastern US Hardwood Forest" Mentor: Jacob Parnell

Aquatics - Adrienne Rodriguez, NCSU

"Revealing Lake Ecosystem Function from Bathymetric, Morphometric and Hydrologic Modeling in ArcGIS" Mentors: Charlotte Roehm, Melissa Slater

Engineering - William Ennis, U of Alabama

"Design and Prototype of STREON Aquatic Organism Exclosure" Mentors: Susan Tower, Andrew Sparks, Ryan Utz

Communications - Abigail Oakes, New College of Florida

"Inclusive Environments – Developing Outreach to Latino Communities" Project Mentors: Jenifer Walton, Sandra Chung, Liz Goehring

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NEON Timeline

CONCEPT & DESIGN	SITES BUILT OUT	DATA COLLECTION
2004 - 2011	2012 - ~2017	~2017 - 2046

Phased transition to operations: 2014 – 2017

30-year clock begins after all sites are completed

Nick Schroeter (D10 Technician) weighing a North American deer mouse during NEON's first season of mammal trapping.

Construction update

Civil construction: 24 sites complete, 8 underway
Sensor deployment: 9 sites underway
Field sampling: 5 sites planned for 2014
Data products: A slow trickle in 2014

Domain Number	Aquatic or Terrestrial	Construction Site	State	Civil Construction	Sensor installation	Data available	Field sampling underway	Site construction complete
D01	TER	Harvard Forest	MA	Completed Fall 2013				
D01	TER	Bartlett Experimental Forest	NH	Underway				
D01	AQU	West Branch Bigelow Brook	MA	Completed Fall 2013				
D02	TER	Blandy Experimental Farm	VA	Completed Spring 2013	Underway			
D02	TER	Smithsonian Conservation Biology Institute	VA	Completed Summer 2013	Underway			
D02	AQU	Posey Creek	VA	Completed Summer 2013				
D02	TER	Smithsonian Environmental Research Center (SERC)	MD	Scheduled Approx. April 2014				

Ongoing updates at:
http://www.neoninc.org/news/construction

CHALLENGES IN THE COMING YEARS

- NEON is ambitious, complicated and untested.
- Construction has been slowed by numerous, unanticipated factors.
- NEON's structure, staffing and function under Operations are uncertain (Ops funding has yet to begin).
- Policies for integration with the science community are still taking shape (assignable assets, access to samples, access to field staff and/or sampling locations?)
- Developing a viable career path for NEON science staff is a major long-term challenge.

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Interaction with AmeriFlux

- Several NEON sites are at or adjacent to AmeriFlux sites
- "Ancillary" data collected by NEON can supplement flux data synthesis activities.
- Design of NEON's FIU system has had substantial input from the AmeriFlux community from the start.
- Collaboration between Fluxnet, NEON and WMO to develop "best practice" guidelines for land-atmosphere exchange measurement.
- AmeriFlux is nimble, NEON is stable.
- Abundant opportunities for future collaboration through synthesis, assignable assets, cross-calibration, etc.

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